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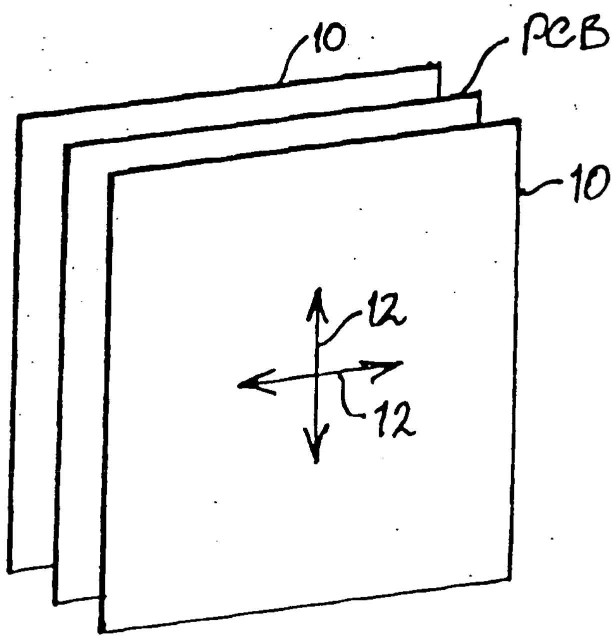

(57) Abstract

A PCB testing device comprising a pair of spaced carriers (10) each divided into individual zones (11), each zone containing a contact probe (16a) movable with respect to the carrier (10) into contact with a PCB under test. Mechanisms (16) are provided to move the probes (16a) selectively within the zones (11) thus, with or without planar movement of the carrier (10), to ensure the probe (16a) may be positioned over any part of the PCB under test.

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A CONTACTING DEVICE

THIS INVENTION concerns a contacting device principally for testing printed circuit boards (PCB's) to determine the integrity of conductor tracks thereon. PCB manufacture requires the testing of boards before they are installed into electronic equipment. Such testing is time consuming and often of extremely high volume. The industry seeks to minimise the time taken for, and thus the cost of, testing PCB's in order to minimise the manufacturing cost of the appliances in which they are installed.

In one known form of test device fixed-position contact pins are provided on a carrier, the pins being deformed and/or positioned on the carrier to match and make contact with a specific circuit pattern on a PCB. Where large volumes of the same PCB design are to be tested, such a dedicated device is advantageous since there are no individual moving parts on the carrier save for the carrier itself being movable into contact with the board. With such a device an entire circuit board is tested in one movement taking, typically, less than 10 seconds for a test. A PCB to be tested might be sandwiched between two such carriers so that circuit tracks on both faces of the PCB may be tested simultaneously.

However, in cases where small or large volumes of PCB's of different design are to be tested then a universally applicable test

device is required which can be readily adjusted and operated in different ways to test different boards.

To address this problem a number of test devices were developed, these being known as "flying probe testers" and typically included four contact probes, (two on each side of the board) and by mounting the probes on carriers adapted to move two-dimensionally along X-Y axes, the probes were able to be accurately positioned over, and to extend into contact with, the board and carry out electrical testing universally according to the board design, computer software being used to determine and effect movements of the flying probes relative to the board to be tested. Although universally adaptable to different board designs, these devices are slow in operation due to the need to move the probes repeatedly to different positions over the board.

Speed of operation was increased by providing additional probes (up to 16) on such a mechanism. This reduced a typical board test time from 60 minutes to approximately 20 minutes.

Further test devices known as "flying grid testers" were developed comprising movable carriers/grids having a continuous array of fixed-position probes arranged very close together thereon such that the carriers are moved by small increments in X-Y axes. This principal minimised the distances by which the probes were required to move and reduced the test time for a PCB from 20 minutes to, typically, 5 minutes.

Currently, manufacturers are seeking universally adaptable devices which can test a typical PCB in less than 1 minute and preferably a few seconds.

A typical PCB with 1000 separate tracks/nets will require 20,000 tests which will either be two point continuity measurements from one point on a track to another point on the same track thus proving connectivity or two or more point tests from a point on a track to another point on a different track thus proving isolation. In the former case the electrical parameters to prove connectivity would typically be 100mA current passed between the two points with a measurement of electrical resistance taken. Typically the threshold between pass and fail would be set to 5 ohms (>5=fail, <5=pass). In the latter case the electrical parameters to prove isolation would typically be 100V potential placed between the two points and a measurement of electrical resistance taken. Typically the threshold between pass and fail would be set to 10,000,000 ohms (>10,000,000 ohms=pass, <10,000,000 ohms=fail).

Of the 20,000 tests it would be normal to have 4000 connectivity measurements and 16,000 isolation measurements. The order in which these measurements are performed is irrelevant, however they must all be performed for the board to be described as fully tested.

In the case of the prior art, especially the flying probe testers, with four probes the tests would be ordered in such a way

that probe movement between tests was minimised but since all tests require two probes, a short move for one probe may dictate that the other has to move a long distance. In this way the machine would move from test to test with the testing part of the cycle making up only a very small percentage of the overall cycle time. Again, referring to flying grid testers, they made the same tests but were able to make shorter moves between tests and hence saved time.

An object of the present invention is to provide a sufficient number of independently moving probes that the tests can be spread between many independent mechanisms which are instructed to move to their next target position immediately after they finish the previous test. During this moving time many or all other test pairs would be moving into position and then carrying out their respective tests. This concept can be described as 'pipe lining' instructions to each of the mechanisms such that in the ideal case it is always in position when the prior test is finished with nothing more to do that actuate the probe such that it contacts the desired point.

The concept of having many independently moving probes also facilitates another time saving concept when running isolation tests. The theoretical number of isolation tests required on a given board where 'n' is the number of tracks is (n x (n-1))/2. In the case of the 1000 track board this would call for 499,500 tests. However, as with the fixture based 'grid testers' where all nets are contacted at the same time, an algorithm is applied whereby isolation is proved between a given track and all other tracks in a single test by connecting the whole group to the stimulus pole of the measurement

circuit. Provided the test passes, the individual track would be ignored and the next track in the group isolated and tested against the rest of the group as before. If a pass is achieved then the test would proceed to the next track and so on until the group is reduced to zero tracks. Hence, the number of tests = the number of tracks and from the example above, 499,500 tests have been reduced to 1,000.

It should be noted that 'flying probe' or 'flying grid' testers do not follow the same concept but instead limit the number of required tests by applying an 'adjacency' algorithm. In brief, this says that tracks which are separated from other tracks do not need to be tested and hence the number of isolation tests is reduced from 499,500 to around 16,000 for the aforementioned board.

However, following the same concept, there are many instances where a number of points can be tested in parallel due to the spread of independent probes across the board. Typically a number of 20 track groups can be contacted in parallel and each time we run the 'scan' algorithm we eliminate (20 x 19)/2=190 tests from the group of 16,000.

Thus by utilising many mechanisms and choosing the optimal sequence in which to run the tests the time lost on prior art machines through moving to the next test in the sequence will be substantially eliminated.

Thus a tester made in accordance with this invention will be fast enough to address the needs of most medium volume manufacturers who will adopt this in place of the fixture based grid machines.

According to the present invention there is provided a contacting device principally for testing printed circuit boards, comprising a plurality of contact members mounted on at least one carrier and movable selectively from a first to a second plane to make electrical contact with a circuit to be tested; characterised in that the or each carrier is divided into a plurality of zones or elements; in that on the or each carrier, in at least some of the zones or elements a mechanism is provided; and in that each mechanism includes at least one contact member movable about its respective zone in said first plane.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying diagrammatic drawings, in which:-

Fig. 1 schematically illustrates a contacting device;

Fig. 2 represents a two-dimensional array/pattern of zones/elements comprising a probe carrier in a contacting device made in accordance with the invention;

Fig. 3 represents a similar array of elements of circular formation;

Fig. 4 illustrates how the array of Fig. 3 may be arranged to maximise coverage over the area of the carrier;

Fig. 5 is a schematic plan view of a test probe mechanism being contained within one circular element of the carrier;

Fig. 6 is a schematic plan view of another form of test probe mechanism contained within one circular element of the carrier;

and Fig. 7 is a schematic plan view of a test probe mechanism contained within one square element of the carrier.

Referring now to Fig. 1 there is shown a PCB testing device consisting of a pair of parallel spaced carriers on blocks 10 so positioned that a PCB under test may be sandwiched between the blocks as shown, the area of the blocks being as great or greater than that of the PCB.

Fig. 2 shows one of the blocks 10 divided into a grid of rectangular elements 11 each of which contains a mechanism (Fig. 7) capable of moving one or more probes mounted thereon to any position within the element. Each such mechanism is capable of moving its probe from the plane of the block 10 (the first plane) into contact with an electrical conductor on the adjacent surface of the test PCB in a second plane. Such movement of the probe is bidirectional thus to make or break contact with the PCB selectively.

The elements 11 are in mutually fixed disposition on the block 10. The complete block of elements can be moved selectively on X-Y co-ordinates as illustrated by arrows 12. Furthermore, of the pair of blocks 10 one can be moved in its first plane independently of the other and the mechanisms and probes of the two blocks can be moved independently of one another. Each mechanism may be moved within its element 11 independently of any of the other mechanisms in the two blocks. Typically, the block may contain some 120 elements uniformly spaced across a block of 60cm x 45cm to test a PCB of similar dimensions.

With such a device, an electrical test is carried out by a minimum of two mechanisms within one or both blocks so that, for example, a probe from one block making contact with an electrical conductor on one face of the PCB may determine continuity of that conductor with another such conductor present, for example, on the opposite face of the PCB and contacted by a probe from the other block. Furthermore, a pair of probes on one block may determine the integrity of a single track or conductor on one face of the PCB.

Referring now to Fig. 3, in another example, each element 10 contains a defined circle 13 and a probe mechanism is mounted in the element such that its probe may move to any position within the circle. The provision of a probe mechanism in every element is a matter of choice but if all elements are so equipped the device is capable of optimum operation universally to test any PCB of a commensurate size and design.

Referring now to Fig. 4, in a further example, the elements may be positioned for maximum coverage by arranging the operative circles 13 in the offset form illustrated thus minimising the uncovered areas of the block. This further reduces the necessary movement of the entire block 10 in order to select any position within its area.

Referring now to Fig. 5, there is illustrated a mechanism 14 of the kind which may occupy one of the circular elements 13 illustrated in Figs. 2 and 3. The mechanism 14 comprises a rotational bar 15 rotatable about the centre of the circle by means of a stepper or servo motor 15a and thus selectable at any angular position in the circle. Movable radially along the bar 15 is a probe actuator 16 carrying a probe 16a which is movable selectively between the first and second planes to make or break contact with the PCB. Thus, the probe can be located angularly and radially with great accuracy anywhere within the circle 13.

If required, in place of the single moving probe actuator 16 a plurality of such probe actuators may be located in spaced radial positions along the bar 15 each being capable of movement along the bar.

Referring now to Fig. 6, in place of the mechanism illustrated in Fig. 4 there may be provided a SCARA robot device having two rotating arms, the first arm 17 rotationally connected at

the centre of the circle 13 with the second arm 18 pivotally connected to the outer end thereof of the first arm, a probe actuator 19 being located on the end of the second arm 18. Once again, with independent stepper or servo motor control the probe can be positioned at any position within the circular element.

Referring now to Fig. 7 and reverting to the concept of a rectangular or square element 11, a probe actuator 20 may be positioned on a pair of linear arms 21 and 22 movable along X-Y axes, again utilising stepper or servo motors to control the movement such that the probe or probes may be positioned anywhere within the area of the square.

It will be appreciated that a test device made as described combines the advantages of a movable carrier or block and movable probes. By providing comprehensive movement of the probes in this way a much faster test process can be carried out reducing the time taken for a typical PCB test to some 30 seconds or less.

As usual, with moving carriers or moving probes computer control of the movable parts is provided to ensure accurate positioning of the probes over a PCB before each probe is moved into contact therewith, and to minimise the number and extent of movements necessary to test an entire PCB.

If preferred, the PCB may be mounted on a carrier, itself movable relative to the probe carriers.

It is not intended to limit the invention to the details described above. For example, it is possible to provide two or more probes movable selectively and independently within an individual element or zone thus to enable positional selection of a pair of test probes anywhere within the bounds of the carrier or block, in which case the carrier itself need not be movable in the first plane.

CLAIMS

1. A contacting device principally for testing printed circuit boards, comprising a plurality of contact members mounted on at least one carrier and movable selectively from a first to a second plane to make electrical contact with a circuit to be tested; characterised in that the or each carrier is divided into a plurality of zones or elements; in that on the or each carrier, in at least some of the zones or elements a mechanism is provided; and in that each mechanism includes at least one contact member movable about its respective zone in said first plane.

2. A contacting device according to Claim 1, wherein the plurality of zones or elements are of mutually fixed disposition.

3. A contacting device according to Claim 1 or Claim 2, including a pair of spaced carriers positioned such that a PCB under test may be sandwiched between the carriers with the area of each carrier being as great as or greater than that of the PCB.

4. A contacting device according to any preceding claim, wherein each mechanism is adapted firstly to move one or more contact members mounted thereon to any position within its zone or element and is adapted secondly to move the or each contact member from the plane of the carrier into contact with an electrical conductor on an adjacent surface of a PCB under test placed in the

second plane, such secondary movement being bidirectional thus selectively to make or break contact with the PCB.

5. A contacting device according to Claim 3, wherein each carrier is movable on X-Y co-ordinates in its first plane and wherein each carrier is capable of movement in its first plane independently of the other carrier, the mechanisms and the contact members of the two carriers being movable each independently of one another.

6. A contacting device according to any one of Claims 1 to 4, wherein each mechanism is capable of movement within its zone or element independently of any of the other mechanisms of the or each carrier.

7. A contacting device according to any preceding claim, wherein each zone or element contains a defined circle, said mechanism being mounted in the zone or element such that its contact member may move to any position within the circle.

8. A contacting device according to Claim 7, wherein the circles are arranged in offset form such as to minimise the areas of the carrier to which a contact member may not move.

9. A contacting device according to Claim 7 or Claim 8, wherein each said mechanism comprises a rotational bar rotatable about the centre of its circle there being a contact member actuator movable radially along said bar and carrying a contact member which is movable selectively between the first and second planes and

whereby the contact member may be located angularly and radially substantially at any position within the circle.

10. A contacting device according to Claim 9, including a plurality of contact member actuators mounted in the or each zone or element and spaced along the rotational bar.

11. A contacting device according to Claim 7 or Claim 8, including a SCARA robot device having two or more rotating arms one of which is rotationally connected at the centre of its circle with the second arm rotationally connected to the outer end of the first arm and the contact member located on the second arm.

12. A contacting device according to any one of Claims 1 to 6, wherein, in a rectangular zone or element, a contact member actuator is positioned on a pair of linear arms movable along X - Y axes respectively wherein the contact member may be positioned substantially at any position within the rectangular zone or element.

13. A contact device according to any preceding claim, wherein each contact member mechanism includes a stepper or servo motor and wherein the movable carriers and/or movable contact members are computer controlled thus to ensure accurate positioning of the contact members over a PCB before each contact member is moved into contact therewith and to minimise the number and extent of movements necessary to test an entire PCB.

14. A contacting device according to any preceding claim, including a further carrier for mounting a PCB such that it is movable relative to the or each zoned carrier.

15. A contacting device according to any preceding claim, wherein the or each zone or element includes two or more contact members movable selectively and independently within the individual zone or element thus to enable positional selection of a pair of contact members anywhere within the bounds of a carrier.

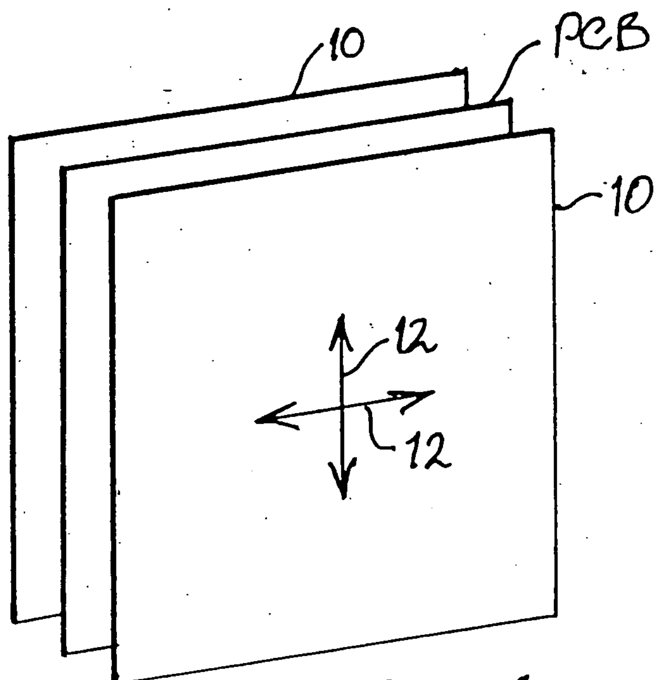

Fig. 1

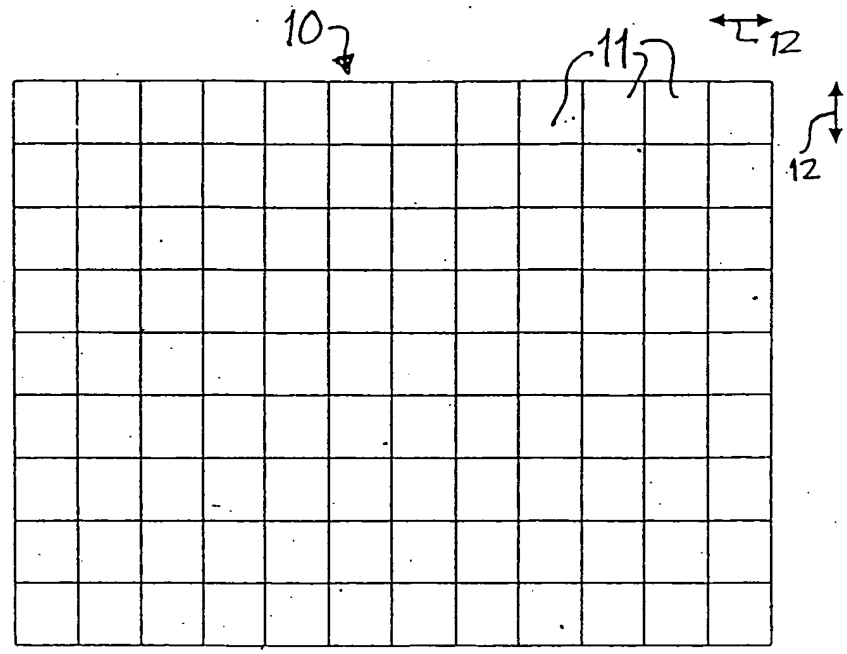

Fig. 2

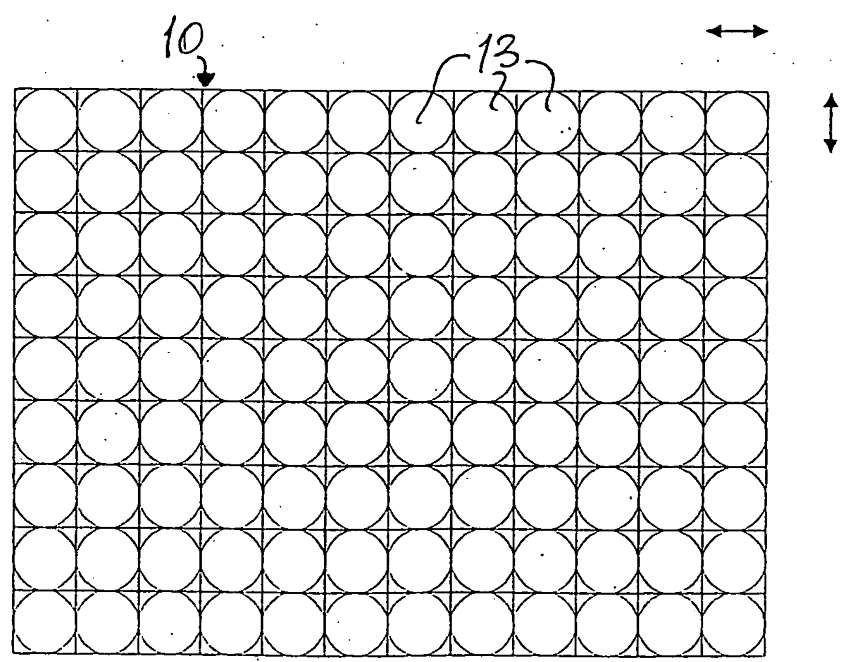

Fig. 3

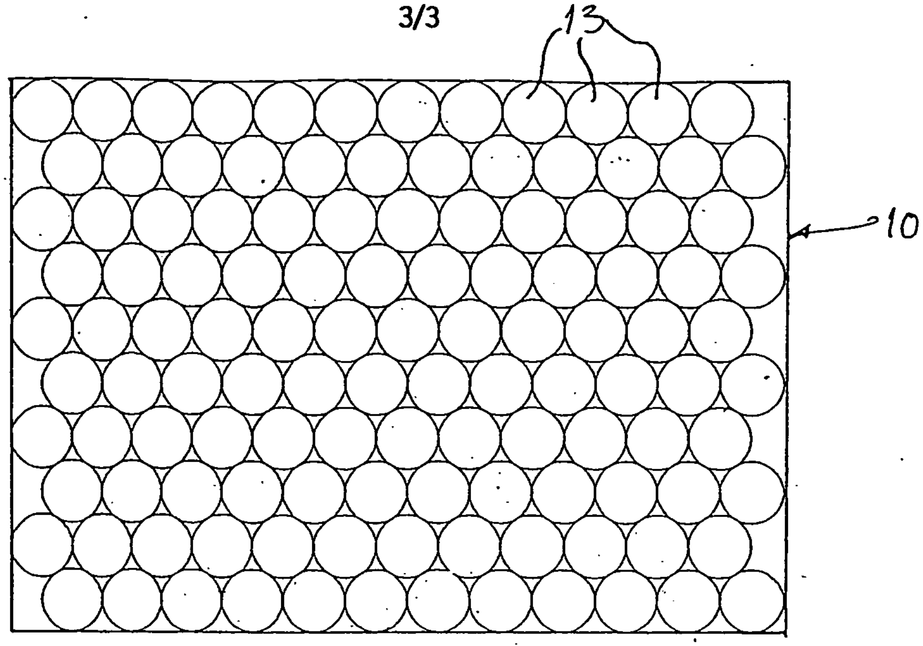

Fig.4

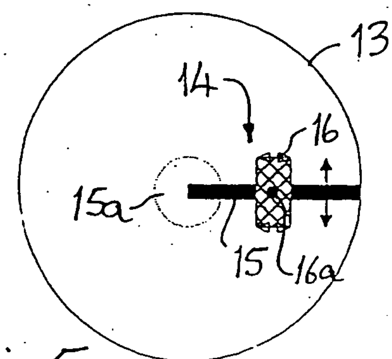

Fig.5

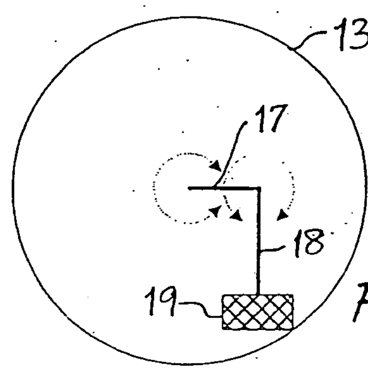

Fig.6

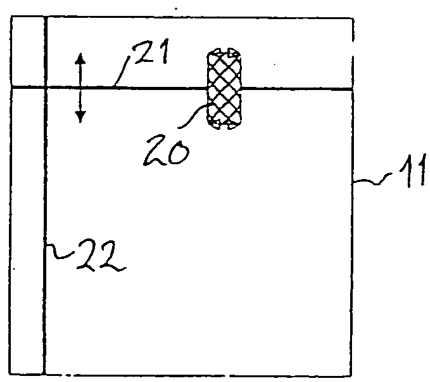

Fig. 7

INTERNATIONAL SEARCH REPORT

International Application No
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A. CLASSIFICATION OF SUBJECT MATTER
IPC 6 G01R1/073

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 6 G01R

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP 0 293 497 A (IBM) 7 December 1988 see claim 1; figure 1	1-10, 12-15
Y	US 3 537 000 A (EASI) 27 October 1970 see column 3, line 66 - line 69; figures 1,2	1-10, 12-15
A	"probe holder for electrical characterization" IBM T.D.B. vol. 37, no. 02a, 1 February 1994, pages 227-228, XP000432626 armonk, ny,us see page 227 -----	1

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
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Information on patent family members

International Application No
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Patent document cited in search report		Publication date	Patent family member(s)			Publication date
EP 293497	A	07-12-1988	JP	1920748	C	07-04-1995
			JP	6050337	B	29-06-1994
			JP	63307370	A	15-12-1988
			US	4908571	A	13-03-1990
US 3537000	A	27-10-1970	NONE			

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